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Remarks

Summary of the Claim Amendments

The Applicants amend Claim 49 as noted above. All other Claims remain unchanged.

Interview Summary

The Applicants appreciate the courtesy extended by the Examiner during the June 15, 2004 Interview. The participants of the interview included Dr. Marci Greci and Brian Johnson, Esq. on behalf of the Applicants and Examiner Ram Kackar on behalf of the United States Patent and Trademark Office ("USPTO"). During the interview, the Applicants explained to the Examiner that the April 5, 2004 Office Action failed to sufficiently consider an element of independent Claim 49. Previously submitted Claim 49 recited a susceptor with "the spacing between facing walls being small enough for said facing walls to heat the exposed face of a facing substrate wafer to substantially the same temperature as said susceptor portion heats a substrate wafer that is in one of said wafer pockets to thereby minimize or substantially eliminate radial and axial temperature gradients across a substrate wafer."

The Applicants argued during the interview that none of the cited references discloses or suggests a susceptor with sidewall spacing as claimed. The Examiner repeated his rejection from the April 5, 2004 Office Action that spacing of the sidewalls is not patentable in light of the respective disclosures of U.S. Patent Nos. 3,659,552 (Briody '552) and 4,848,272 (Ohmura '272) because the Applicants did not show a structural difference in the claimed invention other than the sidewall spacing being "small enough" to heat facing wafers. The Examiner did not find the phrase "small enough" in regard to sidewall spacing to present a patentable improvement over the cited art. The parties did not reach an agreement in regard to the only independent claim at issue in this application. The remarks herein further address the Applicants' position that independent Claim 49, as amended herein, is patentable in light of the cited art.

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Sidewall Spacing

Amended Claim 49 recites a susceptor capable of processing wafers therein with a higher degree of reliability because the sidewall spacing allows for a more even temperature gradient across the wafers. In this regard, amended Claim 49 recites a susceptor

wherein the spacing between facing sidewall sections is unobstructed and so dimensioned that said facing sidewall sections radiantly heat the exposed surface of a facing substrate wafer to substantially the same temperature as said susceptor portion heats a substrate wafer that is in one of said wafer pockets to thereby minimize or substantially eliminate radial and axial temperature gradients across a substrate wafer

The April 5, 2004 Office Action rejects independent Claim 49 as being anticipated by the Briody '552 patent and as being obvious in light of the Ohmura '272 patent. The Examiner addresses the spacing of the susceptor sidewall sections by stating that each cited reference shows a susceptor "spaced optimally to allow flow of reactive gases as well as allow them to heat each other."

The Examiner's broad statement that the cited references already show sidewalls with "optimal" spacing is insufficient to properly reject the spacing element of the Applicants' Claim 49. Discovering the optimum or workable ranges of a known parameter by routine experimentation may fail to show the inventiveness required for patentability. Before the determination of optimal values may be characterized as routine experimentation, however, the parameter at issue must have been previously recognized as a result-effective variable. Optimization of a known problem-solving variable may not be patentable, but that is not the same as identifying that a certain parameter is the variable that solves a problem. An invention may be claimed by identifying the problem solving variable that others have failed to recognize.

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In the claimed invention, the Applicants are the first to identify that the spacing of the facing sidewalls is a problem-solving variable. The cited art in regard to susceptor design neither shows nor suggests that sidewall spacing can effectively resolve an uneven temperature gradient across wafers in a susceptor. The Applicants' novel and nonobvious identification of the sidewall spacing variable in susceptor design achieves a patentable invention as claimed.

Neither the Briody '552 patent nor the Ohmura '272 patent even mentions that the spacing of susceptor sidewalls could be used to improve performance of the susceptor. As discussed in detail below, Briody does not address the sidewall sections radiantly heating each other at all. Briody, therefore, fails to show that the sidewall spacing is a result determinative parameter that could be optimized by routine experimentation. The Ohmura '272 patent requires an inner susceptor positioned "a predetermined space" from an outer susceptor (Col. 2, Line 16) but provides no further insight into how spacing could affect the susceptor design. Both of the cited references are silent as to whether spacing between sidewalls could improve a susceptor's performance in achieving an even temperature gradient.

The Examiner has not shown that sidewall spacing was recognized as a result-effective parameter prior to the Applicants' invention. The Examiner, therefore, has no basis to reject this element as mere optimization. The Examiner's statement that the references show sidewalls "spaced optimally" for the use at hand is insufficient to show or suggest the Applicants' amended recitation that "the spacing between facing sidewall sections is unobstructed and so dimensioned that said facing sidewall sections radiantly heat the exposed surface of a facing substrate wafer"

Rejection under Section 102(b)

The Examiner rejects independent Claim 49 and its dependant claims 22 and 24 as being anticipated by the Briody '552 patent. The Applicants respectfully submit that Briody fails to show every element of the claimed invention within the four corners of the Briody '552 patent. For instance, as discussed above, the Examiner's statement that

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Briody shows "optimally spaced" sidewall sections is an inaccurate assessment of the Briody '552 patent. Other differences are also present that prevent the Briody '552 patent from being a proper reference under 35 U.S.C. § 102(b).

First, independent Claim 49, as amended herein, recites that the susceptor is "defined by a plurality of adjacent straight sidewall sections." Briody shows a round, one piece unit (Figure 4; Col. 4, lines 8-17) and a susceptor formed of rings (Figure No. 1), but Briody fails to show straight sidewall sections as claimed. Having straight sidewall sections is useful in the claimed invention because the facing sections radiantly heat one another across an appropriately dimensioned space. Having straight sidewalls allows for direct alignment of the heating sections. The curved surfaces of the susceptor disclosed in the Briody '552 patent would not provide the linear, more direct heat path from one wafer pocket to another that the claimed straight sidewall sections advantageously present. The Briody susceptors differ from the claimed invention in this regard, and the Applicants respectfully submit that the Examiner's 102(b) rejection is inappropriate.

The Briody patent is also different from the invention recited in independent Claim 49 because the Briody device does not disclose facing sections radiantly heating one another at all. The Briody device heats the wafers only by conducting heat within the body of the susceptor (Col. 1, lines 66-74) and reflecting heat off of additional horizontal members under the susceptor (Col. 2, lines 72-75). By focusing so exclusively on heat conduction within the susceptor and reflection from below the susceptor, the Briody '552 disclosure actually teaches that its side wall sections have insufficient heat radiating across the open space to heat facing wafers.

In fact, Briody notes (Col. 1, lines 66-74) that the centrifugal force of the rotating susceptor holds the supported wafer in constant contact with the susceptor for proper heating. Requiring the maintenance of such contact between the wafer and the drum shows that Briody considers radiant heat from the susceptor body to be insufficient to process the wafers as required. The heat reflecting members (Fig. 1, Ref. No. 40) under the susceptor further show the insufficiency of the radiant heat generated by Briody's device.

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The Applicants' claimed invention solves the problem presented in Briody that portions of the wafers receive inadequate radiant heat in Briody's ringed susceptor. By placing the wafer pockets in straight sidewall sections aligned to heat one another across a properly dimensioned, unobstructed space, the inventors do not have to rely upon the assistance of centrifugal force or reflective members to achieve an even heat conduction across the subject wafers.

The structure of the Briody susceptors further teaches against the Applicants' claimed sidewall sections heating each other across a proper spacing. Briody shows ringed portions of the susceptor separated by vertical spacers (Figure 1, Reference No. 21). The vertical spacers of the Briody patent teach against any reliance upon radiant heat between sidewall sections. The Briody spacers would allow heat across the spacing to escape and would exacerbate the problem of an uneven temperature gradient. The presence of the Briody spacers (Figure 1, Reference No. 21) is another reason why the Examiner's rejection under 35 U.S.C. 102(b) should be removed as requested by the Applicants.

As set forth above, the Briody '552 patent does not anticipate the invention recited in independent Claim 49. Having straight sidewall sections provides a direct path for radiant heat from one section to an opposite section across an unobstructed space. The Briody '552 patent fails to show this element of the Applicants' claim.

Rejections under Section 103

Claims 49, 22, and 24

The Examiner rejects independent Claim 49 and its dependant Claims 22 and 24 under 35 U.S.C. 103(a) as being unpatentable over the Ohmura '272 patent. When applying 35 U.S.C. 103, the following tenets of patent law must be adhered to:

- (A) The claimed invention must be considered as a whole;
- (B) The references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination;
- (C) The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and

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(D) Reasonable expectation of success is the standard with which obviousness is determined.

The Applicants respectfully point to the fact that the Ohmura '272 patent provides no suggestion to form an apparatus with only one susceptor having sidewalls spaced to allow radiant heating of one another. The Ohmura '272 patent provides a susceptor within a susceptor; therefore, the outer susceptor of Ohmura's apparatus could not be dimensioned to provide the claimed unobstructed spacing between sidewalls of a single susceptor as recited in the claimed invention.

The Examiner argues that it would have been obvious to exclude the inner susceptor of Ohmura without affecting the way the Ohmura device works. The Ohmura '272 patent, however, provides neither a motivation nor a reasonable expectation of success for removing the inner susceptor of the disclosed apparatus. The Ohmura '272 design relies upon reflection between the susceptors to provide sufficient heat for processing the wafers therein. Ohmura states (Col. 3, line 68-Col. 4, line 6) that "between first and second susceptors 2 and 5, there is formed an epitaxial growth space, which has its top and bottom defined by reflectors 11 and 12 and its periphery by first and second susceptors 2 and 5 and wafers supported thereby, that is, which is defined by radiation heat reflection surfaces." Both susceptors are required according to Ohmura's own terms. In fact, Ohmura's susceptors must have an outer periphery formed of a "heat reflection material" (Col. 2, Lines 32 and 37) to reflect the heat between wafers located on two separate susceptors. Ohmura further discloses that the wafers themselves have a mirror surface and function as a reflective heat source like the opposed susceptors (Col. 4, Lines 34-38). The Ohmura '272 patent requires both susceptors to define the reflective boundaries necessary to process the wafers therein. Ohmura never suggests that the above-noted "epitaxial growth space" could be formed by opposite walls of a single susceptor.

Ohmura's reliance upon reflective surfaces, including the wafers themselves, is a structural difference from the claimed invention that the Examiner has overlooked in forming the obviousness rejection under §103. Ohmura neither shows nor suggests a susceptor with sidewall spacing so dimensioned that the radiant heat from the sidewall, as

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opposed to heat reflected from every direction, is sufficient to form an even temperature gradient on an opposite wafer. Ohmura's device needs additional reflection because the radiant heat from the susceptor alone is insufficient to evenly heat the "epitaxial growth space." Ohmura even requires the wafers themselves to reflect heat to aid in the epitaxial growth process.

The Applicants respectfully submit that the susceptor of the Ohmura '272 patent would lack proper heating ability if only one, non-reflective susceptor were present. Ohmura neither shows nor suggests that radiant heat from the sidewall, as opposed to reflected heat from every direction, could evenly heat an opposite wafer across a properly dimensioned space. The Applicants' amended Claim 49, in contrast, recites a susceptor that does not require additional reflective surfaces and, if necessary, could process wafers that are not reflective at all. The Applicants' susceptor provides an even temperature gradient across a wafer by each sidewall radiantly heating the sidewall that is properly spaced on the opposite side of the susceptor. Claim 49 has been amended to recite that the invention radiantly heats the surfaces, as opposed to using reflected heat.

The above-noted portions of Ohmura's specification show that Ohmura relies on two susceptors with multiple reflecting surfaces to process the wafers. Ohmura mentions (Col. 5, Lines 10-13) that one of the additional horizontal reflectors may be omitted if the bottom horizontal surface of the outer susceptor is sufficiently reflective. This statement in Ohmura's specification indicates that Ohmura considered ways to reduce the number of parts of the apparatus and never considered eliminating one of the susceptors. In an effort to simplify the susceptor, Ohmura only suggests eliminating the top or bottom reflector. Ohmura's disclosure shows that both susceptors would be required for proper operation. This portion of the Ohmura '272 disclosure negates the Examiner's contention that it would have been obvious to remove Ohmura's inner susceptor for economical or efficiency purposes.

The Ohmura '272 disclosure fails to provide any teaching suggesting the single susceptor of independent Claim 49. The Applicants' invention could only be derived from

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the Ohmura '272 patent by the impermissible use of hindsight gathered from the Applicant's own disclosure.

Claim 50

The Examiner further rejects dependant Claim 50 as being unpatentable, pursuant to 35 U.S.C. 103(a), over the Briody '552 patent in view of U.S. Patent No. 4,579,080 (Martin '080). Claim 50 recites that the susceptor of Claim 49 is formed of graphite coated with silicon carbide. As discussed above, the Applicants respectfully submit that independent Claim 49 is patentable over the cited art. As such, dependant Claim 50 is also patentable. Nevertheless, the Applicants further respond that Briody and Martin are insufficient, either alone or in combination, to defeat the patentability of dependant Claim 50.

Martin discloses a silicon carbide coated susceptor with wafer pockets on the outside of the cylinder (Col. 5, Lines 14-18), such that wafers face a reflective coated outer vessel (Col. 9, Lines 16-18). Briody, on the other hand, discloses the wafer pockets on the inside of the susceptor with the wafers facing each other. The Martin and Briody devices are entirely different in structure and operation.

The Examiner, however, states in the Office Action that it would have been obvious at the time of the Applicants' invention to coat the Briody '552 device with the silicon carbide disclosed in the Martin '080 patent to prevent carbon migration into processed wafers. The Examiner, however, provides no evidence showing that, at the time of the Applicants' invention, preventing carbon migration would have motivated the Applicants to use the silicon carbide coating that Martin discloses. In fact, the Martin '080 patent is silent as to the purpose of the silicon carbide coating. The Examiner has not shown, therefore, that the silicon carbide coating was known to prevent carbon migration prior to the Applicants' date of invention. The Applicants respectfully submit that the combination of the Martin and Briody patents is insufficient to defeat patentability under 35 U.S.C. 103.

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Furthermore, the Briody '552 patent and the Martin '080 patent are too dissimilar to combine for a proper rejection of Applicants' Claim 50. The Martin '080 patent depends upon heat reflective coatings on the reactor vessel for sustaining the proper temperature on the exposed surfaces of wafers on the outer circumference of the cylindrical susceptor (Martin, Col. 9, Lines 16-25; Col. 10, Lines 8-27). The reactor vessel surrounding the outside of the Briody susceptor is inert and heat resistant (Briody, Col. 2, Line 39) but not reflective as required by the Martin '080 patent. The Briody '552 patent, therefore, omits a key feature that is required for the Martin device to be functional. Neither Martin nor Briody offers any teaching or suggestion that the respective disclosures are compatible in a combination.

As discussed above, the device in the Briody '552 patent has features that are detrimental to reliance upon reflected heat, such as the vertical spacers (Fig. 1, Ref. No. 22) that would allow heat to escape. The Martin '080 patent and the Briody '552 patent, therefore, offer no motivation or any reasonable expectation of success in combining their respective devices. The Applicants, therefore, respectfully request that the Examiner withdraw the rejection of Claim 50 under § 103(a).

Standards for the Spacing of Opposing Sidewalls

The Examiner's Office Action states that the Applicants have not provided any standards to determine if the spacing across the susceptor sidewalls of the Ohmura '272 patent would be small enough to allow radiant heating of facing wafers. The Applicants have amended independent Claim 49 to reinforce that the sidewall spacing is of a proper size to perform the stated function—heating opposite wafers across an even temperature gradient. This function provides the standard necessary for the Examiner to evaluate the claim. The Applicants' invention has sidewalls that generate sufficient radiant heat to heat a wafer on an opposite wall, but the cited art cannot achieve this function. The Examiner's Briody and Ohmura devices are incapable of heating facing wafers without relying upon reflecting surfaces to reinforce the radiant heat. In this regard the Briody and Ohmura patents do not meet the standard set forth in the amended independent Claim 49.

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Amended Claim 49 reinforces this functional standard by reciting that the space between facing sections is "so dimensioned" that facing sidewall sections heat each other to provide the desirable even temperature gradient across the body of the wafer. The Applicants respectfully submit that the "so dimensioned" language is a proper way of claiming the variable measurement in terms of the required function. The patent law does not require that all possible lengths corresponding to the sidewall spacing sizes be listed in the patent, let alone that they be listed in the claims. Claiming the sidewall spacing as being "so dimensioned" to allow the desired cross-heating is a definite and accurate functional standard that the cited art fails to achieve.

The Applicants respectfully submit that the element of the amended claim reciting the spacing of the facing sidewall sections is a patentable improvement within the art of susceptor design.

Conclusion

The Examiner's rejections under 35 U.S.C. §§ 102, 103 are insufficient to prevent the patenting of the Applicant's amended claims. The Applicants respectfully request that the Examiner reconsider these rejections and allow each pending claim pursuant to the arguments presented herein.

Respectfully submitted,



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